Important Design of Trickling Filter using NRC Equations Formulas PDF

Formulas
Examples
with Units

List of 21
Important Design of Trickling Filter using NRC Equations Formulas

1) Area given Hydraulic Loading Formula

Evaluate Formula

Formula

$$A = \left(1 + \alpha\right) \cdot \frac{W_w}{H \cdot 1440}$$

Example with Units

$$52.5\,\text{m}^2 = \left(1 + 1.5\right) \cdot \frac{1.4\,\text{m}^3/\text{s}}{4\,\text{m}^3/\text{d} \cdot 1440}$$

2) Hydraulic Loading to each Filter Formula

Evaluate Formula

Formula

$$H = \left(1 + \alpha\right) \cdot \frac{W_w}{A \cdot 1440}$$

Example with Units

$$4.2\,\text{m}^3/\text{d} = \left(1 + 1.5\right) \cdot \frac{1.4\,\text{m}^3/\text{s}}{50\,\text{m}^2 \cdot 1440}$$

3) BOD Loading Formulas

3.1) BOD Loading for First Stage Filter Formula

Evaluate Formula

Formula

$$W' = Q_i \cdot W_w \cdot 8.34$$

Example with Units

$$2.8\text{E-}5\,\text{kg/d} = 0.002379\,\text{mg/L} \cdot 1.4\,\text{m}^3/\text{s} \cdot 8.34$$

3.2) BOD Loading for First Stage Filter using BOD Loading for Second Filter Stage Formula

Evaluate Formula

Formula

$$W = \frac{W'}{1 - E_f}$$

Example with Units

$$3.4286\,\text{kg/d} = \frac{2.4\,\text{kg/d}}{1 - 0.3}$$

3.3) BOD Loading for Second Stage Filter Formula

Evaluate Formula

Formula

$$W' = \left(1 - E_f\right) \cdot W$$

Example with Units

$$2.45\,\text{kg/d} = \left(1 - 0.3\right) \cdot 3.5\,\text{kg/d}$$

3.4) BOD Loading to Second Filter Stage given Efficiency of Second Filter Stage Formula

Evaluate Formula

Formula

$$W' = V_T \cdot F \cdot \left(\left(\frac{1 - E_f}{0.0561}\right) \cdot \left(\left(\frac{100}{E_2}\right) - 1\right)\right)^2$$

Example with Units

$$1.9215\,\text{kg/d} = 0.0035\,\text{m}^3 \cdot 0.4 \cdot \left(\left(\frac{1 - 0.3}{0.0561}\right) \cdot \left(\left(\frac{100}{99}\right) - 1\right)\right)^2$$

4) Efficiency of Filter Formulas

4.1) Efficiency of First Filter given BOD Loading for Second Filter Formula

Evaluate Formula

Formula

$$E = 1 - \left(\frac{W_,}{W'}\right)$$

Example with Units

$$0.825 = 1 - \left(\frac{0.42\,\text{kg/d}}{2.4\,\text{kg/d}}\right)$$

4.2) Efficiency of First Filter Stage Formula

Evaluate Formula

Formula

$$E_1 = \frac{100}{1 + \left(0.0561 \cdot \sqrt{\frac{W'}{V_T \cdot F}}\right)}$$

Example with Units

$$99.216 = \frac{100}{1 + \left(0.0561 \cdot \sqrt{\frac{2.4\,\text{kg/d}}{0.0035\,\text{m}^3 \cdot 0.4}}\right)}$$

4.3) Efficiency of First Filter Stage using Efficiency of Second Filter Stage Formula

Evaluate Formula

Formula

$$E = 1 + \left(\left(\frac{0.0561}{\frac{100}{E_2}} - 1\right) \cdot \sqrt{\frac{W'}{V_T \cdot F}}\right)$$

Example with Units

$$0.867 = 1 + \left(\left(\frac{0.0561}{\frac{100}{99}} - 1\right) \cdot \sqrt{\frac{2.4\,\text{kg/d}}{0.0035\,\text{m}^3 \cdot 0.4}}\right)$$

4.4) Efficiency of Second Filter Stage Formula

Evaluate Formula

Formula

$$E_2 = \frac{100}{1 + \left(\left(\frac{0.0561}{1 - E_1}\right) \cdot \sqrt{\frac{W'}{V_T \cdot F}}\right)}$$

Example with Units

$$100.008 = \frac{100}{1 + \left(\left(\frac{0.0561}{1 - 100}\right) \cdot \sqrt{\frac{2.4\,\text{kg/d}}{0.0035\,\text{m}^3 \cdot 0.4}}\right)}$$

4.5) Overall Efficiency of Two Stage Trickling Filter Formula

Evaluate Formula

Formula

$$E = \left(Q_{ie} - \frac{Q_o}{Q_{ie}}\right) \cdot 100$$

Example with Units

$$2.3902 = \left(24\,\text{mg/L} - \frac{0.002362\,\text{mg/L}}{24\,\text{mg/L}}\right) \cdot 100$$

5) Influent and Effluent BOD Formulas

5.1) Effluent BOD given Overall Efficiency of Two-Stage Trickling Filter Formula

Evaluate Formula

Formula

$$Q_o = \left(1 - \left(\frac{E}{100}\right)\right) \cdot Q_i$$

Example with Units

$$0.0023\,\text{mg/L} = \left(1 - \left(\frac{2.39}{100}\right)\right) \cdot 0.002379\,\text{mg/L}$$

5.2) Influent BOD given BOD Loading for First Stage Filter Formula

Evaluate Formula

Formula

$$Q_i = \frac{W'}{W_w \cdot 8.34}$$

Example with Units

$$0.0024\,\text{mg/L} = \frac{2.4\,\text{kg/d}}{1.4\,\text{m}^3\text{/s} \cdot 8.34}$$

5.3) Influent BOD given Overall Efficiency of Two-Stage Trickling Filter Formula

Evaluate Formula

Formula

$$Q_i = \frac{100 \cdot Q_o}{100 - E}$$

Example with Units

$$0.0024\,\text{mg/L} = \frac{100 \cdot 0.002362\,\text{mg/L}}{100 - 2.39}$$

6) Recirculation Factor Formulas

6.1) Recirculation Factor Formula

Evaluate Formula

Formula

$$F = \frac{1 + \alpha}{\left(1 + \frac{\alpha}{10}\right)^2}$$

Example

$$1.8904 = \frac{1 + 1.5}{\left(1 + \frac{1.5}{10}\right)^2}$$

7) Recirculation Ratio Formulas

7.1) Recirculation Ratio given Hydraulic Loading Formula

Evaluate Formula

Formula

$$\alpha = \left(\frac{H \cdot A \cdot 1440}{W_w} \right) - 1$$

Example with Units

$$1.381 = \left(\frac{4\,\text{m}^3/\text{d} \cdot 50\,\text{m}^2 \cdot 1440}{1.4\,\text{m}^3/\text{s}} \right) - 1$$

7.2) Recirculation Ratio of Wastewater Formula

Evaluate Formula

Formula

$$\alpha = \frac{Q_r}{W_w}$$

Example with Units

$$1.7857 = \frac{2.5\,\text{m}^3/\text{s}}{1.4\,\text{m}^3/\text{s}}$$

8) Volume of Filter Formulas

8.1) Volume of Filter Media given Efficiency of Second Filter Stage Formula

Evaluate Formula

Formula

$$V_T = \left(\frac{W'}{F} \right) \cdot \frac{1}{\left(\left(\frac{1 - E_1}{0.0561} \right) \cdot \left(\frac{100}{E_2} - 1 \right) \right)^2}$$

Example with Units

$$2.2\text{E-}7\,\text{m}^3 = \left(\frac{2.4\,\text{kg/d}}{0.4} \right) \cdot \frac{1}{\left(\left(\frac{1 - 100}{0.0561} \right) \cdot \left(\frac{100}{99} - 1 \right) \right)^2}$$

9) Wastewater Flow Formulas

9.1) Wastewater Flow given BOD Loading for First Stage Formula

Evaluate Formula

Formula

$$W_w = \frac{W'}{8.34 \cdot Q_i}$$

Example with Units

$$1.4\,\text{m}^3/\text{s} = \frac{2.4\,\text{kg/d}}{8.34 \cdot 0.002379\,\text{mg/L}}$$

9.2) Wastewater Flow given Hydraulic Loading Formula

Evaluate Formula

Formula

$$W_w = H \cdot A \cdot \frac{1440}{1 + \alpha}$$

Example with Units

$$1.3333\,\text{m}^3/\text{s} = 4\,\text{m}^3/\text{d} \cdot 50\,\text{m}^2 \cdot \frac{1440}{1 + 1.5}$$

9.3) Wastewater Flow given Recirculation Ratio Formula

Evaluate Formula

Formula

$$W_w = \frac{Q_r}{\alpha}$$

Example with Units

$$1.6667\ \text{m}^3/\text{s} = \frac{2.5\ \text{m}^3/\text{s}}{1.5}$$

Variables used in list of Design of Trickling Filter using NRC Equations Formulas above

- **A** Area *(Square Meter)*
- **E** Overall Efficiency
- E_1 Efficiency of First Filter Stage
- E_2 Efficiency of Second Filter Stage
- E_f Efficiency of First Filter Stage BOD Loading
- **F** Recirculation Factor
- **H** Hydraulic Loading *(Cubic Meter per Day)*
- Q_i Influent BOD *(Milligram per Liter)*
- Q_{ie} Influent BOD Efficiency *(Milligram per Liter)*
- Q_o Effluent BOD *(Milligram per Liter)*
- Q_r Recirculation Flow *(Cubic Meter per Second)*
- V_T Volume *(Cubic Meter)*
- **W** BOD Loading to Filter *(Kilogram per Day)*
- **W,** BOD Loading to the Second Stage Filter *(Kilogram per Day)*
- W_w Waste Water Flow *(Cubic Meter per Second)*
- W' BOD Loading to Filter 2 *(Kilogram per Day)*
- **α** Recirculation Ratio

Constants, Functions, Measurements used in list of Design of Trickling Filter using NRC Equations Formulas above

- Functions: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Measurement: **Volume** in Cubic Meter (m^3)
  Volume Unit Conversion
- Measurement: **Area** in Square Meter (m^2)
  Area Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second (m^3/s), Cubic Meter per Day (m^3/d)
  Volumetric Flow Rate Unit Conversion
- Measurement: **Mass Flow Rate** in Kilogram per Day (kg/d)
  Mass Flow Rate Unit Conversion
- Measurement: **Density** in Milligram per Liter (mg/L)
  Density Unit Conversion

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